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In-group relevance facilitates learning

**In-group relevance facilitates learning across existing and new  
associations**

**Zargol Moradi<sup>1</sup>, Jie Sui<sup>1</sup>, Miles Hewstone<sup>1</sup>, and Glyn W. Humphreys<sup>1, 2</sup>**

**<sup>1</sup>Department of Experimental Psychology**

**University of Oxford**

**South Parks Road**

**Oxford OX1 3UD, UK**

**<sup>2</sup>Department of Speech and Language**

**University of Hong Kong**

**Hong Kong**

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### **Abstract**

Studies have shown that attention prioritizes stimuli associated with the in-group. However, the extent to which this so called '*in-group favoritism*' is driven by relevance is not clear. Here, we investigated this issue in a group of university rowers using a novel perceptual matching task based on the team label-color associations. Across three Experiments participants showed enhanced performance for the in-group stimulus regardless of its familiarity level. These findings confirmed the role of relevance in in-group favoritism. In a further control study, the advantage for certain stimuli was not found in an independent sample of participants who were not identified with the teams but were familiar with the label-color associations, indicating that in-group relevance was necessary for the in-group favoritism. Together these findings suggest that in-group relevance facilitates learning across existing and new associations. The consequences of these findings for understanding in-group effects on perceptual processing are discussed.

**Keywords:** In-group favoritism, In-group relevance, Perceptual matching

## In-group relevance facilitates learning

### Introduction

A common characteristic of a sense of belonging to a group is in-group favoritism (for example see, Brewer, 1979). Biases in favor of in-group members and associated stimuli have been revealed across many studies and contexts over the last fifty years (Allport, 1954; Hewstone, Rubin, & Willis, 2002; Molenberghs, 2013; Ostrom & Sedikides, 1992; Sporer, 2001; Tajfel, 1978; Wilson & Hugenberg, 2010). For example, it has been shown that individuals have enhanced memory for events and stimuli related to their in-group compared to out-groups (for review see, Meissner & Brigham, 2001). In line with this, the effects of group identification on perceptual tasks have also been shown (Rule, Ambady, Adams, & Macrae, 2007). For example, previous studies suggest that group identification can modulate face processing. In the well-known ‘own race bias’ (ORB), individuals show enhanced memory for faces belonging to their own racial group relative to faces belonging to other races (e.g., Brigham, Bennett, Meissner, & Mitchell, 2007). Similarly, own age bias has been documented (Anastasi & Rhodes, 2005). Importantly, studies highlight the role of familiarity in such biases for stimuli such as *faces* to which we are socially habituated (Zebrowitz, Bronstad, & Lee, 2007). Both own-race and own-age biases (or similar biases toward faces) could be explained by the higher amount of contact as well as more frequent exposure to such faces (own race or age) which in turn result in higher levels of familiarity.

However, there is also evidence showing that the in-group favoritism can occur in the absence of long-term experience or familiarity with the stimuli. For example, when individuals are randomly assigned to different groups in laboratory settings they tend to better recognize faces categorized as members of their in-group (Van Bavel, Packer & Cunningham, 2011). Moreover, recent evidence revealed that in-group biases are not limited to stimuli such as faces to which we are habituated and the effects can extend to

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more abstract stimuli (Moradi, Sui, Hewstone, & Humphreys, 2015). These findings suggest that although effects of in-group favoritism can be driven by higher familiarity of the stimuli (Yankouskaya, Rotshtein & Humphreys, 2014) under high saliency, in-group relevance can potentially play a more important role in enhanced memory and attention to the in-group stimuli.

Various theoretical accounts have sought to explain the role of different factors on in-group favoritism (see for example, Mullen, Brown, & Smith, 1992; Otten & Wentura, 2001; Zebrowitz, Bronstad, & Lee, 2007). For example, social identity theory (SIT; Tajfel & Turner, 1985; Turner, Hogg, Oakes, Reicher, & Wetherell, 1987) suggests that upon identifying with a group we tend to categorize self and others into “in-group” and “out-group” and this in turn results in in-group favoritism at different levels (for an extensive review of SIT see Brown, 2000). According to social identity theory, individuals’ social identity is “that part of an individual’s self-concept which derives from his knowledge of his membership in a social group (or groups) together with the value and emotional significance attached to that group membership” (Tajfel, 1981, p. 255). Therefore, it can be argued that an individual’s social identity consists of evaluative, -affective and cognitive components each of which can influence in-group favoritism differently. The evaluative-affective component proposes that “people strive to achieve or maintain a positive social identity thus boosting their self-esteem and that this positive identity derives largely from favorable comparisons that can be made between the in-group and relevant out-groups” (Brown, 2000, p.747) The cognitive component of SIT suggests that individuals’ group membership can bias different aspects of cognition including memory, attention and perception in favor of their in-group (see for example Molenberghs, 2013).

Following on from the cognitive influence of social identification, self-attention theory (e.g. Mullen, 1987) explains in-group favoritism in terms of attentional processes and

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suggests that in-group identification might potentially lead to enhanced attention to in-group attributes. Self-attention theory suggests that three main factors -- including, salience, status and relevance -- contribute to in-group favoritism (for example, see Mullen, Brown, & Smith, 1992; Zebrowitz, Bronstad, & Lee, 2007). However, each of these factors might differently affect the attentional processing regarding one's in-group and out-group. For example, it has been shown that increasing the *salience* of group membership results in higher in-group favoritism (see for example, Taylor, Fiske, Etcoff & Ruderman, 1978). However, the effect of *status* on in-group favoritism is rather controversial. Empirical evidence suggests that members of high status groups show favoritism toward their own group whereas members of low-status groups either show no bias or if they do show bias they tend to favor the high-status out-group members (e.g., Brewer 1979; Brown, 1984; Dutton, 1976). Further, evidence suggests that in-group favoritism is normally stronger on the attributes which are presumed to be most *relevant* or important to the in-group, whereas a 'magnanimous' out-group bias often occurs on unimportant attributes (see Mullen et al., 1992)

The current evidence therefore points to the fact that the factors that we mentioned here, including salience, status, relevance and familiarity, all might play a role in in-group favoritism. However, it is important to investigate the contribution of different factors to in-group favoritism. For instance, despite evidence on the role of familiarity (see for example, Zebrowitz et al., 2007) and relevance (e.g. Van Bavel et al., 2011) on enhanced attention to in-group, the interplay between these factors in the same context has not been investigated before. Understanding the interplay between familiarity and relevance, especially, is of great importance as it might help us to understand how the biases toward in-group are formed.

Here, we investigated the interplay between relevance and familiarity in driving in-group favoritism by adapting a simple perceptual matching paradigm introduced by Sui et

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al. (2012). We manipulated group-relevant colors related to university rowing teams, since colors are an important part of the identity of these groups (Elliot & Maier, 2014; Georgeson & Lampard, 2005). In this context, different blue colors are respectively associated with Oxford (dark blue) and Cambridge (light blue) rowing teams, and these colors are strongly linked to the historical rivalry between the teams (indeed all sports teams of the two universities wear, respectively, dark and light blue colors).

In the task presented to participants, members of the University of Oxford rowing team were instructed to learn different sets of associations (original, swap, novel) between colors and group-relevant labels. For example, in the original setting all color/label associations were based on existing knowledge about the colors of the rowing teams. In this context, participants learned to associate the word “*Oxford*” with a dark blue circle, and the word “*Cambridge*” with a light blue circle. These associations were already learned based on real-world knowledge about the teams. Given that all the participants knew these color-team relations, one would predict small differences in performance in the matching task where participants view different combinations of labels and colors (i.e. Oxford paired with dark blue circle or Cambridge paired with the light blue circle). However, differences in relevance, favoring the in-group, may lead to enhanced performance for in-group stimuli compared with both out-groups (rival and neutral pairings). We hypothesized that there should be enhanced processing and more efficient matching for in-group compared to out-group associated stimuli (Loersch & Bartholow, 2011; Moradi et al., 2015).

We further asked whether an in-group advantage would exist in the absence of any learned color-team associations (equal levels of familiarity but different levels of relevance). To investigate this question, in Experiment 3, rowers performed the same task with three novel colors, in which case there was no prior knowledge about the colors of the teams. Moreover, we asked whether in-group relevance was necessary for enhanced

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performance on a certain association. To answer this question, in Experiment 4, the original colors of the teams were paired with team labels for a group of participants who were students from another university for whom none of the teams were relevant – though in all cases the students were familiar with the real world colors associated with the teams. We hypothesized that even where there is knowledge about the color-team label associations, participants who did not *identify* with a team would perform similarly on all pairs. Therefore, familiarity alone could not drive the advantage in the absence of in-group relevance.

We report four experiments. If the in-group advantage is stable, participants who identified with their in-group team should show enhanced performance for their own team across different settings. If the effect is solely due to existing knowledge about the colors of the different teams, the in-group advantage should only occur in the original (Experiment 1) setting and not in swap (Experiment 2) or novel (Experiment 3) settings. Moreover, if the in-group advantage is strongly dependent on in-group relevance rather than existing knowledge, then participants who did not identify with the teams should not show any effect, regardless of their knowledge about the teams' color (Experiment 4). Together, these four experiments provide a comprehensive picture of how stored knowledge and in-group relevance contribute to in-group advantage.

## Experiment 1: Original color-team label associations

### Method

#### Participants

Participants (Experiment 1 and Experiment 2: 44 participants 21 male, mean age of 21.97, SD = 3.37, range = 18-32) were all right handed, with normal or corrected-to-normal



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vision. All the participants were rowers at the University of Oxford (this included the main Oxford University boat club and the college crews) for at least two months at the time of testing (mean length of membership =  $8.98 \pm 8.68$ , range 2-42 months). Participants were recruited via an internal advertisement with the reimbursement of £10 per hour. Prior to the experiment, all participants completed a written consent form approved by the University of Oxford research ethics committee.

## Stimuli

The shape stimuli were selected by each participant from three different geometric shapes (square, triangle and circle) of 2 degrees of visual angle in size. At the start of the experiment participants were asked which of these shapes they preferred and that shape was then used throughout Experiments 1 and 2 (40% of the participants chose the square, 30% the circle, and 30% the triangle). In the main experiment the chosen shape was presented in three different colors. The colors corresponded to the Oxford University rowing team (dark blue RGB 0, 33, 71), the Cambridge University rowing team (light blue, RGB 163, 193, 173) and Newcastle University rowing team (intermediate blue RGB 11, 18, 238), and these colors were respectively paired with the team labels, Oxford, Cambridge and Newcastle. Thus there was an already-learned color assignment and all participants knew the colors for the selected rowing teams prior to commencing the study. Oxford, Cambridge and Newcastle were chosen because (i) Oxford was the in-group for all the participants; (ii) Cambridge was the traditional rival rowing team (e.g., as highlighted in the annual Oxford vs. Cambridge boat race), and (iii) Newcastle was a non-rival, neutral team.

Each pair (colored shape and team label) was presented in a random order on a grey background (RGB 128, 128, 128) at a visual angle of 4 degrees above or below the fixation cross (0.5 degrees of visual angle in size) with the label always appearing at the bottom and

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the shape at the top. The stimuli were viewed from approximately 57 cm from the 17-INCH monitor display (1920 × 1080 with 60 Hz refresh rate). The experiment was implemented using E-prime software (Version 2.0).

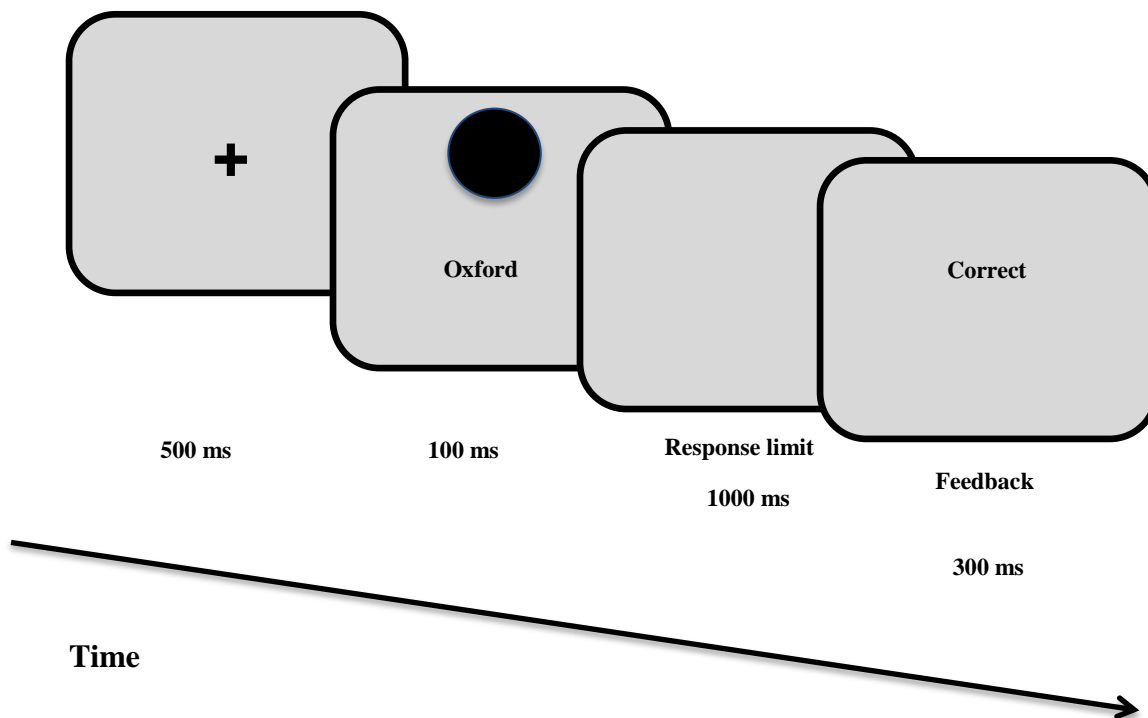
## Procedure

The experiment started with a block of 12 trials in which participants saw each label (Oxford, Cambridge, Newcastle) with its paired colored shape. For example, a circle painted in “Oxford Blue” (dark blue) was associated with the label “*Oxford*”, an intermediate blue circle was associated with the label “*Newcastle*” and a “Cambridge Blue” (light blue) circle was associated with the label “*Cambridge*”. Participants then performed a short practice block of 24 trials where they saw either matched colors and labels or mismatched pairings (e.g., Oxford blue color paired with the label Cambridge). Subsequently the experimental trials were arranged over three blocks. Participants received feedback after each trial throughout the practice and the main experimental blocks. At the end of the experiment participants received feedback showing their overall accuracy across the whole experiment. Each participant completed three blocks of the task in one session of the experiment for a total of 360 trials. All the associations between colors and team labels were based on the real world associations and remained the same throughout the whole session.

Each trial started with a white fixation cross (on the same grey background as used for the display trials) for 500 ms. followed by the simultaneous presentation of a shape, and the label at 4 degrees of visual angle above and below the fixation cross for 100 ms. with the label always appearing below the fixation cross. The stimulus conditions (in-group, out-group, neutral, matched or mismatched) occurred randomly with half of the trials being matched and the other half mismatched. Participants judged whether the color and label

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were a pair as originally shown, or whether they had been re-paired, by pressing one of two different keys on the keyboard (n, m keys). The inter-trial interval varied randomly between 800 and 1200 ms. and the response time was limited to 1000 ms. Trials in which responses were longer than 1000 ms. were aborted. After each trial, participants received written feedback on the computer about whether their response was correct, incorrect or too slow. Response key assignment to matched and mismatched trials was counterbalanced across participants. Figure 1 shows a schematic representation of the task in Experiment 1.



**Fig1.** Example task used in Experiment 1. The original background was fifty percent grey and the shape was painted in dark blue (RGB 0, 33, 71).

Prior to the experiment participants were asked to identify which color went with which university rowing team and they also explicitly rated their level of familiarity with

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each rowing team, with ratings from 1 (*not familiar*) to 7 (*perfectly familiar*). Also, participants were asked to rate how much they liked each color/shape combination from 1 (*not at all*) to 7 (*very much*). There were three different shapes (a triangle, a square and a circle) and three different colors ('Oxford Blue', 'Cambridge Blue' and 'Newcastle Blue'), resulting in nine different combinations of shape and color. Participants additionally rated in general how competitive each rowing team was on a scale from 1 (*not competitive at all*) to 7 (*very competitive*). They were also asked whether or not they had friends among the members of either team.

Participants were also asked to fill in an adapted version of the multicomponent social identity questionnaire (Leach et al., 2008) on a 7-point Likert scale (1 = *strongly disagree* to 7 = *strongly agree*). There were five items for full scale. The subcomponents of in-group identification were solidarity (three items), satisfaction (four items), centrality (three items), individual self-stereotyping (two items) and in-group homogeneity (two items).

## Results

### Ratings

All the participants classed the Cambridge University rowing team as being the rival (to the Oxford University rowing team) and all classed Newcastle University rowing team as being neutral (a non-rival team). Reported effect sizes were calculated for a within subject design (see Morris & DeShon, 2002). The mean ( $\pm$ SD) familiarity ratings were: in-group =  $6.20 \pm .87$ , rival =  $6.00 \pm .89$ , neutral =  $4.60 \pm .78$ . These ratings differed across the teams,  $F(2,86) = 180.01$ ,  $p < .001$ ,  $\eta^2 = .80$ . This difference was due to both the in-group,  $t(43) = 15.23$ ,  $p < .001$ ,  $d = 2.31$ , and rival teams,  $t(43) = 13.49$ ,  $p < .001$ ,  $d = 2.03$ , being

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rated as more familiar compared to the neutral team. The in-group was also rated as being more familiar than the rival team,  $t(43) = 3.09, p < .01, d = .50$ .

The mean ( $\pm$ SD) liking ratings for the original colors were: in-group =  $5.50 \pm .93$ , neutral =  $4.50 \pm 1.20$ , rival =  $3.71 \pm 1.08$ ; with the data averaged across the different shapes). These ratings differed across the teams,  $F(2,86) = 28.77, p < .001, \eta^2 = .40$ , with the in-group team being rated as more liked than the neutral team,  $t(43) = 4.14, p < .001, d = .62$ , and the rival team,  $t(43) = 9.26, p < .001, d = 1.42$ , which again differed,  $t(43) = 2.94, p < .01$  (with the neutral team being rated as more liked,  $d = .44$ ).

The mean ( $\pm$ SD) ratings of competitiveness of each team were: in-group =  $6.07 \pm .81$ , rival =  $6.11 \pm .86$  and neutral =  $4.72 \pm 1.06$ . These ratings also differed across the teams,  $F(2,86) = 48.15, p < .001, \eta^2 = .52$ . The neutral team was rated as less competitive compared to both the in-group team,  $t(43) = 6.69, p < .001, d = 1.03$ , and the rival team,  $t(43) = 9.04, p < .001, d = 1.40$ , acknowledging the international standard of rowing at both Oxford and Cambridge (but not Newcastle). The in-group and rival teams did not differ in terms of how competitive they were rated,  $t(43) = .38, p < .70$ . All participants correctly identified which color went with which team.

Finally the mean ( $\pm$ SD) ratings for the subcomponents for the in-group identification questionnaire were as follows: solidarity =  $17.59 \pm 2.51$  (Max = 21), satisfaction =  $23.13 \pm 3.48$  (Max = 28), centrality =  $15.11 \pm 3.51$  (Max = 21), in-group homogeneity =  $9.70 \pm 1.47$  (Max = 14) and self-stereotyping =  $9.61 \pm 2.42$  (Max = 14).

## RTs

For each participant the responses were filtered to eliminate both very fast (RTs <150 ms.) and very slow (RTs >950 ms.) reaction times. This led to the rejection of 2% of all trials. The analysis was performed on the remaining trials. We first tested whether there

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was any effect of group relevance on RT in Experiment 1 with the original association between colors and team labels. RTs were subjected to a two-way analysis of variance (ANOVA) with two levels of matching condition (matched, mismatched) and three levels of group relevance (in-group, neutral, rival), both manipulated within subjects. All effects were statistically significant at the  $p < .05$ , level. For the multiple comparisons the significance level was set at .01.

Our results revealed that there was a significant main effect of matching condition on RT,  $F(1, 43) = 101.10, p < .001, \eta^2 = .70$ , and group relevance,  $F(2, 86) = 62.14, p < .001, \eta^2 = .59$ , on RT. There was also a significant interaction between matching condition and group relevance,  $F(2, 86) = 73.03, p < .001, \eta^2 = .63$ , indicating that the difference between RTs on matched and mismatched trials varied as a function of group relevance. We conducted post hoc comparisons separately on match and mismatch trials to understand how the RTs for the pairs with different group relevance were affected by the matching condition. On match trials participants were quicker to respond to in-group stimuli compared to stimuli linked to the rival team,  $t(43) = 10.86, p < .001, d = 1.67$  (mean difference  $\pm$  SD =  $66 \pm 40$ ), and the neutral team,  $t(43) = 12.03, p < .001, d = 1.83$  (mean difference  $\pm$  SD =  $88 \pm 48$ ), and RTs were also faster on rival team stimuli compared to the neutral items,  $t(43) = 3.70, p < .001, d = .56$  (mean difference  $\pm$  SD =  $23 \pm 40$ ). However, on mismatch trials there was no significant effect of group relevance ( $.18 < ps < .58$ ).

We further tested whether there was any correlation between the RT and the strength of in-group bias based on the scores on the multicomponent in-group identification questionnaire. We did not find any significant correlations.

## **d' and response criterion**

To examine the sensitivity of discriminating between match and mismatch trials in

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the task we calculated  $d'$  and response criterion measures. These measures are specifically useful for the current task since the response is binary (deciding whether the shape and label are a match or a mismatch, or “yes” vs. “no” in the terminology of signal detection theory).  $d'$  is often used instead of percentage correct and is a measure of correctly discriminating signal from noise (or here match from mismatch). In mathematical terms  $d'$  is the difference between the distribution of signal and noise means in standard deviation units (see Macmillan & Creelman, 2004). The smallest detectable difference between signal and noise is response criterion. The smaller the criterion is, the more sensitive the participant is to detect signal from noise (here match from mismatch). Using  $d'$  and response criterion measures ensures that the participants were not simply biased toward specific responses for some conditions (for more details see Swets, Tanner, & Birdsall, 1961).

For each participant, we calculated  $d'$  as a measure of sensitivity for discriminating match and mismatch trials across the different conditions.  $D'$  was derived using the Green and Swets (1966) formula, taking the data for mismatch trials based on the team label that was presented.

$$d' = z(H) - z(F)$$

In addition, the response criterion ( $C$ ) was calculated using the following formula (Macmillan, 1993):

$$C = -\frac{1}{2} [z(H) + z(F)]$$

We tested whether there was any effect of group relevance on  $d'$  as a measure of sensitivity of discriminating between match and mismatch trials (Green & Swets, 1966).

There was a significant effect of group relevance on  $d'$ ,  $F(2, 86) = 123.91$ ,  $p < .001$ ,  $\eta^2 =$

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.74. Pairwise comparisons showed that  $d'$  for in-group stimuli was significantly larger compared to both neutral,  $t(43) = 15.23$ ,  $p < .001$ ,  $d = 2.29$  (mean difference  $\pm$ SD =  $1.08 \pm .47$ ), and rival items,  $t(43) = 12.05$ ,  $p < .001$ ,  $d = 1.80$  (mean difference  $\pm$ SD =  $.94 \pm .51$ ); the latter did not differ,  $t(43) = 1.90$ ,  $p < .07$ .

Analyses of the response criterion also revealed a significant main effect of group relevance,  $F(2, 86) = 67.09$ ,  $p < .001$ ,  $\eta^2 = .60$ . Post hoc comparisons showed that the criterion for the in-group was significantly lower than that for the neutral stimuli,  $t(43) = 10.80$ ,  $p < .001$ ,  $d = 1.57$  (mean difference  $\pm$ SD =  $.56 \pm .34$ ) and rival stimuli,  $t(43) = 7.13$ ,  $p < .001$ ,  $d = 1.01$  (mean difference  $\pm$ SD =  $.33 \pm .30$ ). The criterion for the rival team was also lower than that for neutral stimuli,  $t(43) = 4.86$ ,  $p < .001$  (mean difference  $\pm$ SD =  $.23 \pm .32$ ),  $d = .71$ .

In Experiment 2 (swap), the associations between the colors and team labels were manipulated to test whether any differences between the original conditions reflected the participants' prior knowledge of the color-team label assignment and if there was any residual effect of the Experiment 1 (already-learned) on subsequent learning and associative responding.

There were two different swap conditions with half of the participants randomly assigned to each condition. For the *neutral swap*, participants learned to associate the shape in 'Newcastle blue' with the label "Oxford" and vice versa for the label "Newcastle". In this case the Cambridge stimulus (rival team) remained the same. For the *rival swap* condition, participants associated the shape in 'Cambridge blue' with the label "Oxford" and vice versa for the label "Cambridge" ('Oxford blue'). Here the Newcastle stimulus (neutral team) remained the same. As before, half of the experimental trials were "match" (the color and the label were paired according to the experimental instructions) and the other half were "mismatch" (the label and the color were not correctly paired). Here, again



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participants judged whether the color and team label was a pair according to the experimental instruction or whether they had been re-paired by pressing one of two different keys on the keyboard (k, l keys). The assignment of the response keys to the match and mismatch trials was counterbalanced across participants. Note that the response keys for the Experiment 2 (k, l) were different from those of Experiment 1 (n, m).

## Participants

All forty-four participants who completed Experiment 1 took part in Experiment 2. The order of Experiments 1 and 2 was counterbalanced across participants. There was a twenty minute gap between experiments.

## Results

### RTs

We tested whether there was an advantage on RTs for in-group stimuli in the swap experiment similar to the one we found in the original condition and whether any in-group advantage differed as a function of the color-team relations being swapped. We used a 2 x 3 x 2 mixed model ANOVA on RTs with matching condition (match vs. mismatch) and group relevance (in-group, neutral, rival) as within-subject variables and swap condition (swap color with the neutral team vs. swap color with the rival) as a between-subject variable. Overall, twenty-two participants were randomly assigned to the swap-neutral condition and the remaining twenty-two assigned to the swap-rival condition. The results showed that the main effect of swap on RTs was not significant,  $F(1,42) = .37$ ,  $p < .55$ ,  $\eta^2 = .009$ ; nor was the interaction between swap and matching conditions,  $F(1,42) = .07$ ,  $p < .78$ ,  $\eta^2 = .004$ , or between swap and group relevance,  $F(2,84) = 2.43$ ,  $p < .10$ ,  $\eta^2 = .002$ . The three-way interaction was also not reliable,  $F(2,84) = .08$ ,  $p < .93$ ,  $\eta^2 = .002$ .

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However, there were significant main effects of matching condition,  $F(1,42) = 55.93$ ,  $p < .001$ ,  $\eta^2 = .57$ , and group relevance on RT,  $F(2, 84) = 15.71$ ,  $p < .001$ ,  $\eta^2 = .28$ . The interaction between matching condition and group relevance was also significant,  $F(2, 84) = 23.41$ ,  $p < .001$ ,  $\eta^2 = .36$ . In order to decompose the interaction effect and to understand how the effect of group relevance on RTs varied across the matching conditions we conducted post hoc comparisons on match and mismatch trials separately. Our results showed that, for match trials, participants were significantly faster to respond to in-group compared to both neutral,  $t(43) = 6.74$ ,  $p < .001$ ,  $d = 1.01$  (mean difference  $\pm$ SD=  $41 \pm 40$ ), and rival stimuli,  $t(43) = 8.45$ ,  $p < .001$ ,  $d = 1.28$  (mean difference  $\pm$ SD =  $47 \pm 37$ ). The neutral and rival stimuli did not differ,  $t(43) = .82$ ,  $p < .416$ . For the mismatch trials none of the comparisons were significant ( $.14 < ps < .88$ ).

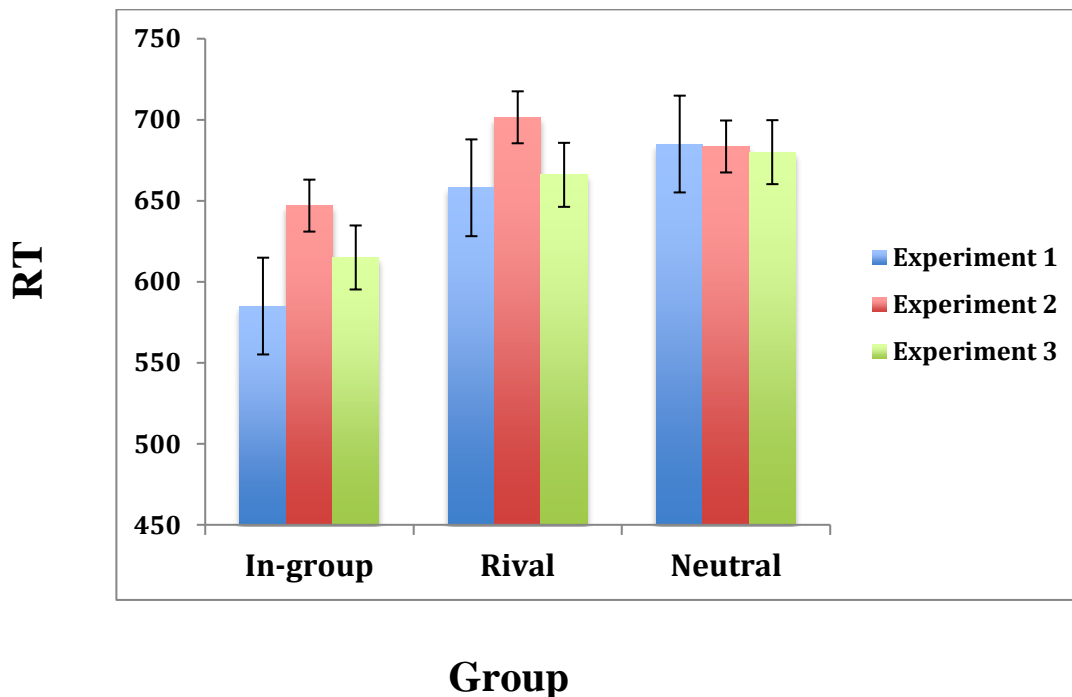
## **d' and response criterion**

As before, we tested whether there was any effect of group relevance on d' as a measure of sensitivity of discriminating between match and mismatch trials (Green & Swets, 1966).

We computed a 2 x 3 ANOVA on both d' and response criterion with group relevance as a within- and swap condition as a between-subject variable. The results showed that there was a significant main effect of group relevance on d',  $F(2, 84) = 31.47$ ,  $p < .001$ ,  $\eta^2 = .43$ . Post hoc comparisons showed that d' was significantly larger for in-group compared to both neutral stimuli,  $t(43) = 4.28$ ,  $p < .001$ ,  $d = .65$  (mean difference  $\pm$ SD =  $.32 \pm .50$ ) and rival stimuli,  $t(43) = 9.23$ ,  $p < .001$ ,  $d = 1.48$  (mean difference  $\pm$ SD =  $.56 \pm .40$ ). There was also a larger d' for neutral compared to rival stimuli,  $t(43) = 3.12$ ,  $p < .01$ ,  $d = .79$  (mean difference  $\pm$ SD=  $.23 \pm .50$ ). However, there was no significant main effect of swap condition on d',  $F(1, 42) = .17$ ,  $p < .68$ ,  $\eta^2 = .004$ . The interaction between group relevance and swap condition was not significant,  $F(2, 84) = 1.06$ ,  $p < .36$ ,  $\eta^2 = .026$ .

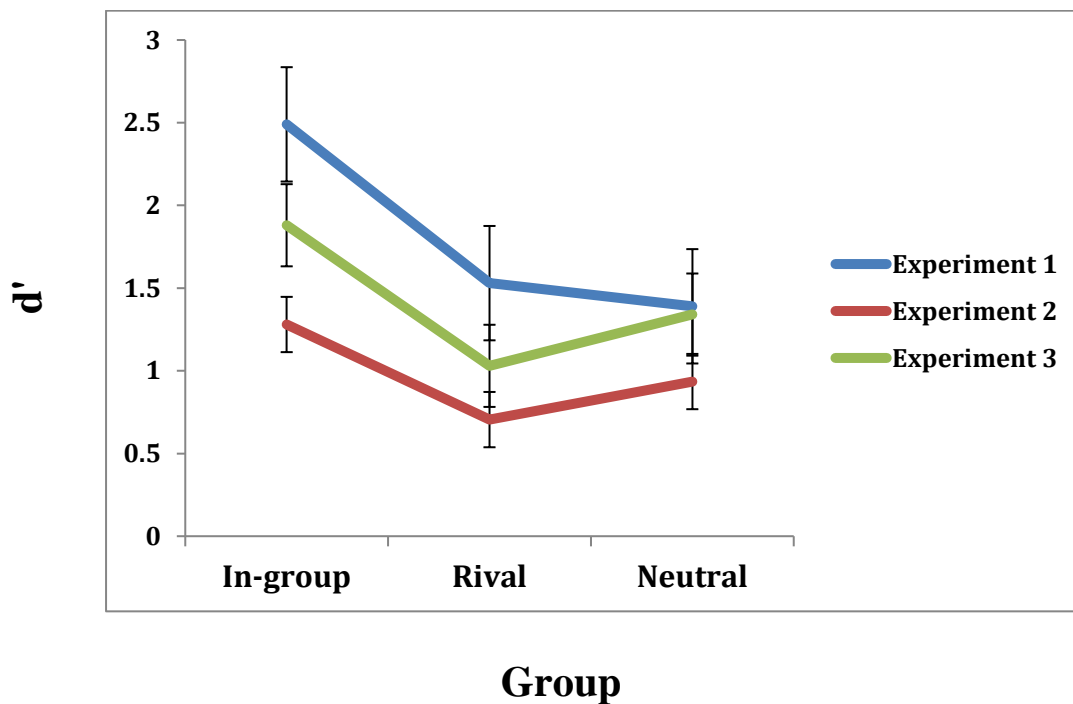
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Analyses of the response criterion data showed that there was a significant main effect of group relevance on the response criterion,  $F(2, 84) = 70.10$ ,  $p < .001$ ,  $\eta^2 = .62$ . Post hoc comparisons showed that the response criterion was significantly lower for in-group compared to both neutral stimuli,  $t(43) = 8.66$ ,  $p < .001$ ,  $d = 1.29$  (mean difference  $\pm$ SD =  $.35 \pm .27$ ) and rival stimuli,  $t(43) = 9.57$ ,  $p < .001$ ,  $d = 1.43$  (mean difference  $\pm$ SD =  $.52 \pm .36$ ). The response criterion for neutral stimuli was also lower than for rival stimuli,  $t(43) = 4.11$ ,  $p < .003$ ,  $d = .63$  (mean difference  $\pm$ SD =  $.17 \pm .27$ ). There was no significant main effect of the swap condition on the response criterion,  $F(1, 42) = .28$ ,  $p < .59$ ,  $\eta^2 = .007$ , and no interactions involved this factor,  $F(2, 84) = 2.81$ ,  $p < .075$ ,  $\eta^2 = .06$ . Results for the RT and accuracy data are shown in Figures 2a & 2b.



**Fig 2a.** Mean RT for the matched trials in Experiments 1, 2 & 3.

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**Fig 2b.** Mean  $d'$  for Experiments 1, 2 & 3.

## Discussion

We tested, first, whether there was an effect of in-group relevance on simple perceptual matching. Second, we tested whether this effect was modulated by using stimuli with already-learned original associations vs. when the learned associations were swapped. We used two different sets of associations between colors and team labels. In the experiment with original associations (Experiment 1) the real world team colors were associated with the corresponding team labels. In the swap experiment (Experiment 2), for half of the participants the in-group label was paired with the original (real world) color of

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the rival team and for the other half, the in-group label was paired with the original (real world) color of the neutral team.

Our results showed that performance on match trials was enhanced for associations related to the in-group compared to the other associations. This effect was present in both reaction time and  $d'$  with no evidence of a speed-accuracy trade off. The results for  $d'$  confirmed that participants had enhanced sensitivity for discriminating between match and mismatch trials for the in-group team compared to the other teams. Participants were also faster to judge the match in-group trials compared to the other pairs. Such effects of *in-group advantage* were present in both the *original* and *swap* conditions. This suggests that, in cases of both already-learned and new associations, the perceptual advantage for in-group stimuli was stable.

Although performance was better for the in-group associations, there was less evidence of a cost to performance for the rival compared with the neutral team. In the original condition (long-term associated colors) and the neutral swap condition, performance for the rival team did not differ from the neutral team. There was no clear evidence here that there was any-cost to the rival when it had to be re-assigned to the color of the in-group. The one exception to this was that there was a drop in  $d'$  for rival stimuli, suggesting some drop in sensitivity. This is consistent with some degree of suppression then taking place.

Along with the effects on RTs and  $d'$  there were some effects on the response criterion. The response criterion was lower for in-group stimuli than for the other items. The response criterion results fit with participants adopting a less conservative criterion when responding to in-group stimuli, as well as showing enhanced perceptual sensitivity. The relations between the response criteria for neutral and rival teams were, however, unclear, and varied across conditions.

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### **Experiment 3: Novel color-team label associations**

In Experiment 3, we tested whether there was still better performance for the in-group relative to the other teams when associations had to be built between the team labels and some novel colors with no history of real world connections to the teams. Here, in contrast to Experiment 1, the teams were assigned completely new colors for associative matching. We tested whether the in-group advantage remained under these conditions.

## **Method**

### **Participants**

Twenty-four members of Oxford college rowing teams (eleven male; mean age (SD) =  $23 \pm 2.67$  years, range, 18-28) took part. Participants were all right handed with normal or corrected to normal vision.

### **Stimuli and Procedure**

The stimuli and the procedure were identical to Experiment 1 except that the color associated with each of the three stimuli was novel. In this case any effect linked to the familiarity of the real world colors was eliminated. The three novel colors were: pink (RGB, 153, 34, 24), beige (RGB, 226, 177, 179) and orange (RGB, 226, 70, 20). The colors assigned to each team were counter-balanced across participants. The same words as in Experiment 1 ("Oxford ", "Cambridge ", and "Newcastle") were used.

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### Results

For each participant response times were carefully inspected to filter for both very fast (RTs <150 ms) and very slow performance (RTs > 950 ms). This led us to reject 2% of the total number of trials. Mean liking ratings, taken before any associations were formed were: pink ( $4.91 \pm 1.10$ ), beige ( $4.80 \pm 1.03$ ), and orange ( $4.87 \pm .89$ ). These ratings did not differ significantly,  $F(2,46) = .251$ ,  $p < .78$ .

### RTs

RTs were subjected to a two-way within-subject ANOVA with two levels of matching condition (match, vs. mismatch) and three levels of group relevance (in-group, neutral, rival). All effects were statistically significant at  $p < .05$ , and for multiple comparisons at  $p < .01$ . There were significant main effects of matching condition,  $F(1,23) = 116.20$ ,  $p < .001$ ,  $\eta^2 = .83$ , and group relevance,  $F(2, 46) = 4.82$ ,  $p < .02$ ,  $\eta^2 = .18$ , on RT. There was also a significant interaction between matching condition and group relevance,  $F(2, 46) = 8.19$ ,  $p < .001$ ,  $\eta^2 = .26$ , indicating that the difference between RTs on match and mismatch trials varied as a function of group relevance. To decompose the interaction effect we conducted the post hoc comparisons separately on match and mismatch trials. The results showed that, for the match trials, participants were quicker to respond to in-group compared to the neutral,  $t(23) = 3.95$ ,  $p < .001$ ,  $d = .80$  (mean difference  $\pm$ SD =  $48 \pm 59$ ), and rival teams,  $t(23) = 3.85$ ,  $p < .001$ ,  $d = 1.11$  (mean difference  $\pm$ SD =  $50 \pm 64$ ). There was no significant difference between the neutral and rival teams,  $t(23) = .22$ ,  $p < .84$ . On mismatch trials there was no significant difference between the teams,  $.21 < ps < .63$ .

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### **d' and response criterion**

Next, we tested whether there was any effect of group relevance on d'. The results revealed that the main effect of group relevance,  $F(2,46) = 31.21$ ,  $p < .001$ ,  $\eta^2 = .57$  was significant. Pairwise comparisons showed that d' was significantly larger for the participant's own team compared to both the neutral,  $t(23) = 4.60$ ,  $p < .001$ ,  $d = .96$  (mean difference  $\pm SD = .75 \pm .79$ ), and rival teams,  $t(23) = 6.99$ ,  $p < .001$ ,  $d = 1.43$  (mean difference  $\pm SD = 1.02 \pm .71$ ). However, d' was also larger for the neutral team compared to the rival team,  $t(23) = 3.39$ ,  $p < .01$ ,  $d = .67$  (mean difference  $\pm SD = .26 \pm .38$ ).

We also tested whether there was any effect of group relevance on the response criterion. The results showed a significant main effect of group relevance,  $F(2, 46) = 18.96$ ,  $p < .001$ ,  $\eta^2 = .45$ . Post hoc comparisons revealed that the criterion for the in-group association was significantly lower than for the neutral stimuli,  $t(23) = 5.18$ ,  $p < .001$ ,  $d = 1.05$  (mean difference  $\pm SD = .45 \pm .43$ ) and the rival stimuli,  $t(23) = 5.01$ ,  $p < .001$ ,  $d = 1.00$  (mean difference  $\pm SD = .44 \pm .43$ ). Results for the RT and accuracy data are shown in Figures 2a & 2b.

## **Discussion**

We found evidence that, with novel color-team label associations, participants were still faster and showed higher sensitivity when performing a matching task on the in-group stimulus compared with rival and neutral items. This confirms that the *in-group advantage* is robust across different contexts and does not require the involvement of already-learned associations for the advantage to emerge. These results seem to suggest that in-group relevance results in in-group advantage in a perceptual matching task and this can occur in the absence of any long-term associations between the color and team labels. The findings of this experiment therefore rule out the mere effect of stored knowledge on in-group



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favoritism and establish the stable effect of in-group relevance on a perceptual matching task.

## **Experiment 4:**

### **Performance in individuals not affiliated with the teams**

In Experiment 4, we tested whether associating a color to a label affected subsequent matching performance in individuals who did not identify with either of the rowing teams in question. The colors were those used in Experiment 1. However, the participants were no longer Oxford University rowers, though they retained knowledge of which color went with which team. With a similar level of familiarity with color/team label associations, if there are intrinsic differences between these colors that make some easier to match than others, then the pattern of results should resemble that found in Experiment 1 (there should be an enhanced performance for a certain team because of the color itself). On the other hand, the enhanced performance for a certain team might require that participants highly identified with a certain team (note our questionnaire results); in which case for individuals who report little interest in rowing and who were not members of the university rowing teams we used for the associations, the performance should be similar for all teams.

## **Method**

### **Participants**

Twenty-seven participants (twelve male), mean age =  $21 \pm 3$  years (range 18-27 years) took part. Participants were recruited via an internal advert at the University of Birmingham. Participants were all right handed with normal or corrected-to-normal vision.

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## Stimuli and Procedure

The stimuli and the procedure were identical to Experiment 1 with already-learned associations. Before the experiment participants were asked to rate on a scale (from 1= *not at all*, to 7= *very much*) how much they liked each color. Participants were also asked whether or not they knew the associations between the colors and the team labels. They also rated the familiarity of each team on scale (from 1= *not familiar at all*, to 7= *very familiar*).

## Results

Participants were asked whether they classed Oxford, Cambridge and Newcastle rowing teams, respectively, as the team they support, the rival or the neutral team. All participants classed all three teams as neutral with no group bias. All participants confirmed that they knew about color-team associations. They also confirmed that they knew about the rivalry between Oxford and Cambridge University rowing teams. For each participant responses were filtered to remove both very fast (RTs <150 ms) and very slow RTs (>950 ms). This led to the rejection of 6% of the trials. Seven participants were excluded due to very poor overall accuracy (accuracy rate < .30 in more than one condition) and the analysis was conducted on the remaining twenty participants. The mean (SD) familiarity ratings were: Oxford = 4.50±.67, Cambridge = 4.30±.48, Newcastle = 4.15±.36. These ratings did not differ across the three teams,  $F(2,38) = 1.93$ ,  $p < .16$ ,  $\eta^2 = .09$ . The mean color liking ratings were Oxford = 4.12±1.26, Cambridge = 4.55±1.17, Newcastle = 4.37±1.02. Again these ratings did not differ,  $F(2,38) = .73$ ,  $p < .48$ ,  $\eta^2 = .03$ .

## RTs

First, we tested whether or not there was an effect of team and match condition on RTs. We used a  $2 \times 3$  repeated measures ANOVA with match condition (match vs.

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mismatch) and team (Oxford, Newcastle, Cambridge) as within-subject variables. The analysis revealed a significant main effect of match condition,  $F(1,19) = 36.80, p < .001, \eta^2 = .66$ . Pairwise comparisons showed that participants were in general faster on match trials compared to mismatch trials,  $p < .001$  (mean difference  $\pm \text{SEM} = 42 \pm 7$ ). However, there was no significant main effect of team on performance,  $F(2,38) = 1.20, p < .32, \eta^2 = .06$ . The interaction between the match condition and team was not significant,  $F(2, 38) = .83, p < .41, \eta^2 = .04$ .

### **d' and response criterion**

We tested whether there was any effect of team on d'. The results showed that there was no significant effect,  $F(2,38) = 1.2, p < .30, \eta^2 = .06$ , nor was the effect of team reliable on the response criterion,  $F(2,38) = .68, p < .51, \eta^2 = .03$ . The mean RTs (ms) and accuracy data are shown in Table 1.

**Table 1.** Mean Reaction Times and Accuracy as a function of match condition (match vs. mismatch) in Experiment 4.

Group	Reaction Time		Accuracy	
	Matched	Mismatched	Matched	Mismatched
Oxford	630(61)	686(61)	.75(.16)	.70(.20)
Cambridge	636(66)	674(68)	.73(.15)	.67(.21)
Newcastle	648(62)	686(67)	.71(.21)	.71(.17)

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### **Discussion**

Individuals with no connection to the rowing teams showed no advantage in matching learned associations for any of the team labels and their linked color – despite the fact that the participants knew the team-color associations. These results indicate that there were no intrinsic advantages for the earlier experiments' in-group color (Oxford blue) compared with the colors associated with the neutral and rival teams. In addition, the data suggest that having knowledge of the associations is not sufficient to generate the in-group advantage; although we note that the degree of familiarity individuals had with the color-team associations was lower here than was the case for the rowing-related participants in Experiment 1 (based on subjective ratings of familiarity).

Based on our findings, we propose that it is the in-group relevance of the participant's own team (in Experiments 1, 2 & 3) that drives better performance on both reaction time and response accuracy. Knowledge about teams with which one does not identify is not enough to modulate matching performance to learned associations.

### **General Discussion**

Across four experiments we provided evidence showing that, in a simple perceptual matching task, participants show in-group advantage. In Experiment 1, participants who were more highly identified with a University rowing team were faster and had higher sensitivity when matching their in-group team label and color compared with when they had to match labels and colors for neutral and rival rowing teams. This result was not caused simply by stored knowledge about, or familiarity with, the color of in-group team. First, the rated familiarity for the colors of the in-group and rival teams did not differ; and the basic in-group advantage effect was still found when colors were re-assigned to in- and out-groups (Experiment 2, swap conditions). Second, in Experiment 3, there remained an in-group advantage for participants associated with

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the rowing team even when novel colors, with which participants had no prior experience, were introduced. In addition, in Experiment 4 we found that there was no advantage for the learned in-group color-team label associations for participants who did not identify with the in-group, although they had knowledge about the color-team label associations. This last result indicates that the in-group advantage in Experiment 1 was not due to some intrinsic differences between the colors, to which the unaffiliated participants ought also to be sensitive. It could be argued that the degree of familiarity with the in-group color was greater for the participants linked to their home-university rowing team, and that was critical, but then the data from Experiment 3 cannot be explained in that way. We conclude that differential familiarity was less important than in-group relevance for generating the in-group advantage.

The effect of social relations on responses to newly-associated stimuli has recently been studied by Sui and colleagues in the context of self-bias. Sui, He and Humphreys (2012) had participants carry out a simple matching task based on a newly-established association between a word corresponding to a person (you, friend, stranger) and a geometric shape (circle, square, triangle). Participants discriminated whether label-shape pairs were the same as initially established (match condition) or whether the items were re-paired (mismatch condition). They showed that response times were substantially faster to self-related pairs than to pairs for other people (see also Frings & Wentura, 2014). In a further study, Sui, Lui, Mevorach and Humphreys (2013) further showed that the self-associated shapes, when placed in hierarchical (local-global) forms with shapes associated with other people, acted as high-saliency stimuli – interfering with identification responses to the shape for the other person. This interference effect was similar to that found when the perceptual saliency of shapes is varied (Mevorach, Hodsoll, Allen, Shalev & Humphreys, 2010).

Extending previous work in this area, we also examined the effects of swapping the learned color-label assignments. Despite these swaps, there remained an advantage for the in-group

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stimuli (Experiment 2). These results again suggest that the basic in-group advantage effect does not depend on knowledge about the sensory properties of the particular in-group stimulus (e.g., here the color associated with each university rowing team), since the effect survives color re-assignment (Experiment 2, swap conditions) and it also occurred when in- and out-group stimuli were assigned novel colors (Experiment 3).

As well as there being an advantage for in-group stimuli, there was some evidence from the  $d'$  results that there is a cost associated with rival stimuli, though this was not reliable for RTs. Lower  $d'$  for the rival indicates less sensitivity in discriminating between match and mismatch trials. It may be that there is some degree of suppression for stimuli associated with the rival team, lowering perceptual sensitivity for these items.

How can in-group identification generate these effects? One account argues that in-group identification heightens the salience of the stimulus, enhancing matching for in-group stimuli (Sui et al., 2013; Moradi, Sui, Hewstone, & Humphreys, 2015). A second is that in-group identification enhances the integration between the two elements making up each stimulus (the color and the label), with the consequence again being that there is better matching for in-group stimuli. There is evidence for both of these effects from work on self-bias, as we outline below. It has been argued that the in-group gains salience via its connection to the self (Otten & Epstude, 2006). This could explain why perception prioritizes in-group stimuli in a similar way manner to self-related stimuli (Turner, 1987). As noted in the introduction, Sui et al. (2013) reported that self-related stimuli generated effects similar to those of stimuli with high perceptual salience, when the stimuli formed hierarchical forms (in this case when global letters were made up of local letters). An fMRI study conducted under the same task conditions further showed that rejection of the self-associated distractor was associated with increased activity in the left intra-parietal sulcus (compared to when the self-associated stimulus was the target). The region of increased activation overlapped with an area previously reported as being activated when

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participants reject distractors that are made attentionally salient (Mevorach et al., 2009, 2010). Such overlap in the neural responses for self-associated as well as salient stimuli is consistent with the social association mimicking the effects of altering attentional salience through a perceptual manipulation. We propose that a similar process applied to in-group rather than self-related stimuli could be responsible for the results presented here.

The second account is that in-group identification can modulate integration between the color and the label. Moradi and colleagues (Moradi, Yankouskaya, Duta, Hewstone, & Humphreys, 2016) have examined perceptual integration of color and shape under conditions of in-group association. In their studies, participants learned associations between shapes and colors (in-group, out-group). The task then was to respond to either or both features (color or/and shape) of in- and out-group associated stimuli, with trials containing a single shape, single color or a single target containing both shape and color. Their results showed that there were redundancy gains in which responses were faster on the trials where both features (shape and color) were present than when a single feature (either color or shape) appeared (e.g., Miller, 1982). Moradi and colleagues (2016) report that, specifically for in-group associated targets, there were enhanced redundancy gains and there was evidence for non-independent (integrated) processing of the stimuli. This was not the case for the out-group target. These results indicate that stimuli associated with the in-group enhance perceptual integration. Here, the in-group advantage might reflect enhanced binding and perceptual integration of color-team labels. We note that both arguments rest on the in-group advantage reflecting similar processes to those mediating self-biases. However, it has been argued that participants may represent in-group stimuli in a manner that is close to their representation of self-knowledge (Otten & Epstude, 2006). So, although these proposals require further empirical verification, they are reasonable in the light of prior research findings.

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In addition to the above accounts, better performance for in-group stimuli could be attributed to the motivation to respond correctly to the in-group pairs. We suggest that increased motivational relevance for in-group items could both enhance attentional salience and facilitate the binding of the elements, facilitating matching for these items. Motivational processes are at the core of social identity and self-categorization theories (Tajfel, 1978; Tajfel & Turner, 1979). This theoretical approach holds that, when an individual's social identity becomes salient in an intergroup context, it can lead to attentional focus on in-group relevant information (Brown, 2000; Tajfel, 1978). Consequently, this social identity-based motivation is likely to produce an in-group advantage in behavior (Brewer & Brown, 1998; Hewstone, Rubin, & Willis, 2002). So, in line with SIT principles, the presence of a feature associated with an in-group (here the in-group word or color) may shift an individual's attention toward the in-group stimuli based on the motivation to attend to the in-group (Tajfel 1981; Tajfel & Turner, 1985; see also Yzerbyt & Demoulin, 2010). The in-group advantage effects can emerge even at a minimum level of exposure to the in and out-group stimuli, as we showed here, when we paired in-group information with previously novel colors (Experiment 3).

To conclude, our findings across four experiments suggest that in-group relevance plays an important role in in-group favoritism. This was replicated under both high and low familiarity conditions where the color of teams was already learned and highly familiar (Experiment 1) as well as where the associations between novel colors and team labels were not familiar and had to be learned (Experiment 3). Where participants had no connection to the teams, performance on the task did not differ for different teams, further confirming that relevance is necessary for in-group favoritism to emerge. With familiarity controlled, our research was able, first, to confirm the role of *relevance* on in-group favoritism, and second, to indicate that familiarity is not sufficient to induce bias, but in-group relevance is necessary to induce in-group favoritism. The *interplay* between these factors in the same context has not



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been investigated before. Understanding the interplay between, especially, familiarity and relevance is of great importance as it might help us to understand how biases in favor of the in-group are formed.

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